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EXHIBIT 1

UNITED STATES DISTRICT COURT
CENTRAL DISTRICT OF CALIFORNIA

STEVE ODDO, RAJENE REARDON, ANTHONY LASALA, LINDA LAMM, KEITH KIMBALL, NORMAN KLINGE and DAN GALLAGHER, on behalf of themselves and all others similarly situated, Plaintiffs, v. ARCOAIRE AIR CONDITIONING AND HEATING, CARRIER CORPORATION, BRYANT HEATING AND COOLING SYSTEMS, COMFORTMAKER AIR CONDITIONING & HEATING, INTERNATIONAL COMFORT PRODUCTS LLC, and UNITED TECHNOLOGIES CORPORATION, Defendants.	)	**CLASS ACTION** CASE NO. 8:15-cv-01985 CAS (Ex)

Expert Report of Paul J. Sikorsky, P.E.

February 12, 2018

I. SCOPE OF ENGAGEMENT AND BACKGROUND

1. I have been engaged by Chimicles & Tikellis LLP and Shepherd, Finkelman, Miller & Shah, LLP, on behalf of Plaintiffs in this matter, to provide my opinions concerning the alleged defect involving the presence of Ryconox in certain HVAC systems manufactured by Carrier Corporation ("Carrier").

2. I am a registered Professional Engineer with over 30 years of experience in manufacturing. I have substantial experience in the HVAC manufacturing industry, having worked for twenty-seven years in various engineering capacities at Trane Inc. ("Trane"), which is one of the largest HVAC manufacturers in the U.S.. During that time, for example, I held positions as Senior Principal Materials Engineer in Materials and Chemistry, Project Manager, and Director of Strategic Supply Engineering. In those roles, I have developed a deep understanding of the design, manufacture, function, and servicing of residential and light commercial HVAC systems like those involved in this case.

3. In my work at Trane, I was a member of the development team for the first scroll compressor introduced in the HVAC industry. I was the materials engineer on that team and was responsible for selecting the materials of construction used in the compressor as well as evaluating all of the components of the compressor as they were developed and tested. This included evaluations of component quality, wear, corrosion, breakage, etc., all of which are pertinent in this case.

4. In my work at Trane, I regularly visited all of Trane's domestic, and many of Trane's international, manufacturing facilities as well the manufacturing facilities of Trane suppliers around the world. I am intimately familiar with the manufacturing processes used to produce air conditioning machines and components in those machines including compressors, coils, motors, valves (including TXVs), bearings, copper tubing and fans.

5. In my work at Trane, and as a consultant, I have also conducted hundreds of failure analyses of HVAC machines and components to determine root causes and recommend remedial action.

6. I have a B.S. degree in Metallurgical Engineering from The University of Michigan and an M.S. degree in Metallurgical Engineering from Michigan Technological University.

7. I was the chair of the Materials Property Database Committee for ASM International (formerly American Society for Metals), and the B5.05 Copper Casting Subcommittee of ASTM (formerly American Society of Testing and Materials). I have received a Distinguished Service Award from ASTM. I was a founding member of the Heat Treat Society. For several years I helped write and grade the Professional Engineering Exam for Metallurgical Engineers.

8. I have spoken at national conferences on the topics of fluid bed heat treating, materials selection, and steelmaking.

9. I was an instructor for ASM Courses entitled "Metallurgy for the non-metallurgist" and "Steelmaking."

10. I was a co-contributor and reviewer for two books: ASM INT'L, ASM READY REFERENCE: PROPERTIES & UNITS FOR ENGINEERING ALLOYS (1997) and ASM INT'L, ASM READY REFERENCE: ELECTRICAL AND MAGNETIC PROPERTIES OF METALS (2000).

11. I currently serve as a consulting engineer for Global Engineering Associates, LaCrescent, MN. My CV is attached as Exhibit A. A copy of my testimonial record for the past four years is attached hereto as Exhibit B.

12. My opinions and a summary of the factual bases for them are set forth herein. My work on this matter is ongoing, and my opinions are subject to revision based on new information that subsequently may be provided to or obtained by me. This report represents only those opinions I have formed to date. I understand that as of the date of my Report, discovery in this matter is ongoing. I reserve the right to modify or supplement my opinions based on additional discovery, as well as any information disclosed in any expert reports submitted by other parties in this proceeding, as well as my continuing analysis of the materials already provided, and on any new information, materials, and analyses related to the expert reports in this case.

13. In formulating my opinions in this case, Plaintiffs' counsel provided me access to all documents produced in this litigation by Carrier, Emerson Climate Technologies ("Emerson"), and Lennox. I reviewed a large volume of documents. Some selected materials that I reviewed and relied upon are cited below or listed in

Exhibit C. I also conducted my own review and analysis of certain publicly available documents, selected examples of which are also listed in Exhibit C.

II. MY DUTIES AS AN EXPERT WITNESS AND COMPENSATION

14. I understand that, as an expert witness, my first duty is to the court and that I must honestly give my opinions concerning this case in this report and in response to any questions that may be put to me concerning this case.

15. I am not aware of any connection between myself and any of the parties that could in any way influence or be thought to influence my consideration of the issues or the opinions expressed in my report.

16. In connection with my work as an expert, Global Engineering Associates is being compensated at a rate of $250 per hour, or $300 per hour for deposition testimony and court appearances, plus $125 per hour for travel time. I have received no other forms of compensation in relation to this case. No portion of my compensation is dependent or otherwise contingent upon the results of this action or the specifics of my testimony.

17. There are facts contained within the report that come from my own knowledge. I confirm that, insofar as the facts in my report are within my own knowledge, I have made clear that I believe them to be true and that the opinions I have expressed represent my true and complete professional opinion.

III. SUMMARY OF OPINIONS

18. As set forth more fully below, my opinions include the following:

A. THE PRESENCE OF RYCONOX IN THE HVAC SYSTEMS IS A MATERIAL DEFECT: The presence of the rust inhibitor Ryconox in the compressors of Carrier's HVAC systems is a material defect. This conclusion is overwhelmingly supported by many facts, which are summarized below. Ryconox is well-known in the industry to cause sticky debris to form on thermostatic expansion valves ("TXVs").

B. ALL CARRIER HVAC SYSTEMS CONTAINING RYCONOX ARE DEFECTIVE, EVEN IF A TXV FAILURE HAS NOT YET BEEN

REPORTED TO CARRIER: Carrier's records show an approximate [redacted] greater chance of an acute TXV failure in the first year alone with Ryconox. Through December 2017, [redacted] *at least* about [redacted] of all 1.5-2.5 ton units containing Ryconox have failed, and these systems were at most only 4 years old. Carrier projected a roughly [redacted] failure rate. These failure rates are extremely high, but, in reality, all of the systems containing Ryconox are defective, even if no acute TXV failure has been reported to Carrier. Due to the nature of the defect, all or virtually all of the units containing Ryconox have, or likely will, suffer performance losses due to Ryconox deposits. In Carrier's "extreme conditions" lab testing, virtually every HVAC system experienced a high superheat condition, even though some systems took the accelerated equivalent of many years to manifest a high superheat condition. Moreover, the evidence shows that consumers have experienced performance loss and do not know it.

C. ALL 1.5 TO 5 TON SYSTEMS ARE DEFECTIVE: Carrier's bulletins are limited to 1.5 to 2.5 ton units. Nevertheless, all 1.5 to 5 ton units containing Ryconox are defective. Ryconox is well-known in the industry to cause sticky debris to form on TXVs. While larger systems may take longer to manifest severe failures, this does not mean they are not defective. The evidence summarized below is clear. Carrier's own internal documents admit that Ryconox affects 3 to 5 ton systems, and [redacted]. Likewise, reports from the field, studies by Carrier's competitors, and examination of the means by which Ryconox deposits on TXV pins shows that 3 to 5 ton systems are affected by the Ryconox defect.

D. THE COST TO REMOVE OR REMEDIATE THE RYCONOX AT THE TIME OF PURCHASE CAN BE DETERMINED ON A CLASS-WIDE BASIS: I have been asked by Plaintiffs' counsel to opine as to the means and cost to repair the defective HVAC units at the time of purchase. In other words, what would it cost a consumer to make the product defect-free at the time of purchase? As set forth more fully below, there are at least two methods by which the Ryconox could have been removed or remediated at the time of installation, and the costs of doing both can be calculated and applied on a class-wide basis:

1) At minimum, it would have been possible to remediate the effects of Ryconox by injecting the defective HVAC systems with Zerol Ice at the time of installation. Carrier believed that Zerol Ice was an effective preventative, but Carrier declined to provide Zerol Ice as a preventative due to cost and an inadequate supply of Zerol Ice among other reasons. The cost for these injections can be calculated on a class-wide basis. Indeed, Carrier calculated such costs on a class-wide basis for 1.5 to 2.5 ton systems. The process is the same for all 1.5 to 5 ton systems, and, as such, this amount can be easily applied to all units in the class definition. As set forth below, I have calculated a conservative average cost for preventative injections at the time of purchase, including labor and parts (*i.e.*, the Zerol Ice itself), of $150 per unit. This is well-below what Carrier reimbursed for labor alone for curative injections of Zerol Ice, and also below its projections for the cost of preventative injections. Thus, the $150 per unit amount provides a conservative floor.

2) As set forth below, however, while injecting Zerol Ice prevents Ryconox deposits, the evidence shows that Zerol Ice is also harmful to the HVAC systems. Accordingly, the cost of injecting Zerol Ice is not fully compensatory. Therefore, in the alternative, I also calculate the cost of a process that would have fully removed Ryconox at the time of purchase. This process would involve replacing the Ryconox-containing compressor at the time of purchase, replacing it with a Ryconox-free compressor, and recharging the unit with refrigerant. As set forth more fully below, I calculate that the average cost of performing this service would be $320 in labor, plus the cost of a new compressor. Exhibit D is a price list for the compressors used in Carrier's affected units. As shown there, the weighted (by volume) average price per compressor is $709. So, the total

average cost that would have been incurred to fully repair the systems at the time of purchase is $1,029.[1]

E. INJECTING ZEROL ICE DOES NOT PROVIDE CONSUMERS A DEFECT-FREE HVAC SYSTEM; INSTEAD, WHILE IT ADDRESSES THE SYMPTOMS OF RYCONOX, IT CAUSES DAMAGE AND CREATES NEW RISKS. Zerol Ice is highly acidic, it causes copper plating, it causes lead leaching from compressor bearings, it causes zinc leaching from brass, [redacted] As such, while injecting Zerol Ice may remediate Ryconox-related deposits, it does not provide a defect-free system. The evidence of this fact, discussed below, is strong.

F. THE COST OF REMEDIATING ZEROL ICE CAN BE CALCUALTED ON A CLASS-WIDE BASIS. Because injecting Zerol Ice does not result in a defect-free system, Plaintiffs' counsel asked me to opine as to the cost of remediating systems that have been injected with Zerol Ice. As described below, that average cost is $1,152, and again it can be easily applied on a class wide basis.

IV. BACKGROUND

<u>The 'Frozen Coil Issue'</u>

19. By late-spring or early-summer of 2014 Carrier was aware of an increase in the number and rate of warranty claims for failed TXVs in residential air conditioners and heat pumps. This problem was often referred to as the "Frozen Coil Issue," though the failures manifested themselves in several ways including high superheat, loss of performance, as well as frozen evaporator coils.

20. Carrier quickly determined "conclusively that the root cause of the TXV contamination" was a new rust inhibitor in the compressors of the HVAC systems, called Ryconox 20M, which the compressor manufacturer, Emerson, had begun using in November 2013. The rust inhibitor was causing sticky deposits to form on the TXVs.

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[1] Since Carrier's records show the compressor model numbers for each HVAC system, we can easily apply the specific cost for each compressor model on a class-wide basis as well.

21. The propensity of certain rust inhibitors to cause TXV clogs was well-known in industry long before Emerson began using Ryconox. So, even before Carrier knew that Emerson had started using Ryconox, Carrier knew that the clogs were "Likely From Either A Rust Inhibitor, [or] Miscell. Metal Working Fluid." (CARRIER_0002292).

22. To understand the technical issues in this case it is important to have a fundamental understanding of how an air conditioner works.

23. At a very basic level, an air conditioner works by transferring heat from the inside of a building to the outside of a building via the sequential evaporation and condensation of a working fluid, *i.e.*, the refrigerant. In a typical "split system," there is an outdoor unit (the condenser) and indoor unit (the evaporator). The outdoor unit includes the compressor, a coil (a long length of tubing that is "coiled," which allows for heat transfer), and a fan to blow outside air over the coil. The indoor unit (or evaporator) includes a valve to release pressure on the refrigerant, a coil, and another fan. Essentially, the compressor in the outdoor unit compresses the refrigerant, which increases the pressure and temperature of the gas. Outside air is then blown over the outdoor coil to reduce the temperature of the hot refrigerant, and the refrigerant condenses to liquid. The liquid refrigerant is then moved to the indoor unit where the pressure is relieved causing a dramatic decrease in the temperature of the refrigerant as it moves into the indoor coil. A fan then blows household air over the cold indoor coil, which cools the home while the liquid refrigerant boils and changes to a gas. The refrigerant then circulates back to the outdoor condenser unit where the process begins again.

24. During this process, as the refrigerant moves between the compressor and the indoor coil and back again, it undergoes a phase change from gas to liquid and back again. Gaseous refrigerant changes to a liquid state in the outdoor coil. When the pressure is released by the valve in the indoor unit, the refrigerant undergoes a phase change back to a gas in the indoor coil. Then, it moves back to the compressor, where the process is repeated. These phase changes are what facilitate the efficient removal of heat from inside the building and the ejection of that heat to the outside.

25. Exhibit E is a schematic representation of these components for a typical residential split system air conditioner. The refrigerant circulates inside these components in the direction shown with the arrows.[2]

26. Also, circulating with the refrigerant is oil that is required to lubricate the compressor, serves to provide some lubrication of other moving parts like valves, and provides additional sealing. Anything else circulating inside the refrigeration circuit of the air conditioner is considered a contaminant. Moisture, residual lubricants and other fluids from manufacturing, and dirt and debris are some of the more common contaminants sometimes found in refrigeration systems. Because these contaminants can hinder unit performance and reliability, it is common to include a device called a filter-drier in the refrigeration circuit to eliminate them or mitigate their effects.

27. The evaporator is the place in the air conditioner where cooling happens. From the schematic in Exhibit E we see that a low temperature, low pressure **liquid** enters the evaporator coil, while a low temperature, low pressure **gas** exits the evaporator coil. It is critical that all of the liquid refrigerant entering the evaporator is converted to gas before exiting the evaporator and, more importantly, that it remains a gas before entering the compressor. The compressor is designed and built to compress gas but not liquids. Liquids entering the compressor can cause severe damage.

28. To ensure that no liquid refrigerant enters the compressor (potentially damaging it), the refrigeration circuit is designed such that the refrigerant gas exiting the evaporator is superheated. Superheat is defined as the difference between the actual temperature of a gas and its saturation temperature (or boiling point, *i.e.*, when a liquid changes phase to a gas). For example, water boils at 212 degrees Fahrenheit at sea level. If you have steam (*i.e.*, gaseous water) at 232 degrees Fahrenheit at sea level, then it has a superheat of 20 degrees F, or 20 degrees above its boiling point. In the case of an evaporator, the superheat is the difference between the temperature of the refrigerant exiting the evaporator and its saturation temperature (boiling point) at that point. In other words, it is the difference between the actual temperature and the temperature at which a phase change will occur. Too

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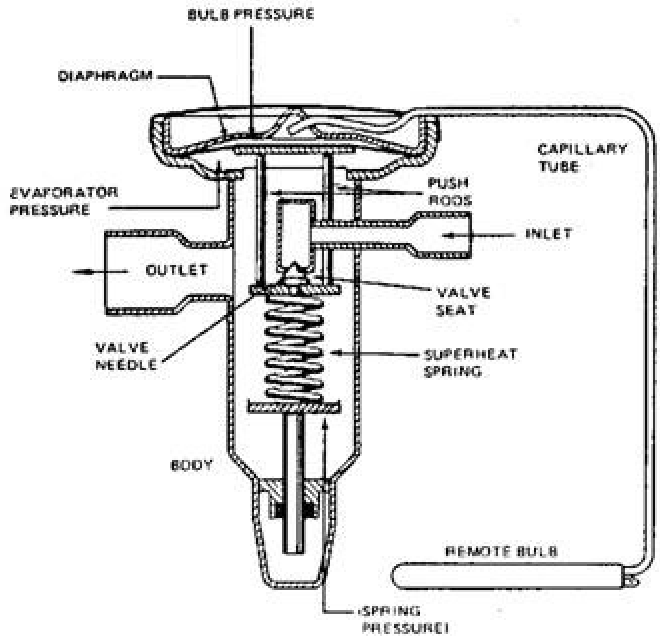
[2] Generally, Carrier sells outdoor and indoor units separately – they are not "married" prior to purchase. So, for example, a consumer could purchase an outdoor unit manufactured in February 2014, and an indoor unit manufactured in February 2015. A small number of HVAC systems at issue in this lawsuit are "packaged" units, which refers to a single unit that contains both the indoor and outdoor components. The basic function of a packaged unit is the same, however.

little superheat, meaning the refrigerant is close to its liquid state, could result in liquid refrigerant reaching the compressor. Too much superheat, meaning the temperature is too far above the saturation temperature, reduces the cooling performance of the system, which in turn reduces its energy efficiency since it will take longer to cool the home.

29. The expansion device is the component that reduces the pressure and temperature of the high temperature, high pressure liquid refrigerant to lower pressure and temperature before it enters the evaporator coil. As the pressure of the liquid refrigerant drops, so does its saturation temperature (boiling point). For example, water boils at lower temperature at higher altitude because the atmospheric pressure decreases. At sea level water boils at 212 degrees F, whereas at 15,000 feet altitude water boils at 185 degrees F.

30. Historically, expansion devices were simple orifices – fixed diameter holes. The refrigerant would pass through the fixed orifice and expand. The size of the orifices was optimized to provide adequate superheat for typical operating conditions. However, since actual operating conditions vary, the amount of superheat in refrigerant exiting the evaporator would vary. As superheat increases, the capacity of the evaporator decreases and efficiency suffers. As superheat decreases, the chances of sending liquid to the compressor increases. The goal is to provide superheat at the lowest possible level while assuring that the compressor is never flooded with liquid. A fixed orifice provides excessive superheat over much of the normal operating map.

31. As demands for energy efficiency increased in more recent years, manufacturers needed a more precise means of controlling the expansion of refrigerant, so superheat could be optimized over a wide range of conditions. Manufacturers began using thermal expansion valves, or TXVs, instead of fixed orifice expansion devices. A TXV uses the temperature of the refrigerant exiting the evaporator and the pressure of the refrigerant in the evaporator to control the flow of refrigerant through the valve and into the coil to maintain constant superheat over a wide range of operating conditions. It does this by actuating a metering pin within the valve in response to changes in those variables. The pin is tapered and moves in and out of a hole or seat. As the tapered pin moves in or out of the seat, it allows more or less refrigerant to pass through to the evaporator coil. The following diagram shows the essential component of a typical TXV, with the valve seat and needle (or pin) labeled:



The remote bulb shown in the schematic contains a small amount of refrigerant. When the TXV is installed in the unit, that bulb is attached to the evaporator coil exit tube so that the refrigerant in the bulb is at the same temperature as the refrigerant exiting the evaporator coil. When the temperature in the evaporator coil increases, the pressure in the remote bulb and capillary tube also increases and exerts a force through the diaphragm to open the valve. The pressure of the liquid refrigerant coming into valve also acts to open the valve. The forces attempting to open the valve from the bulb and the incoming refrigerant are countered by the forces exerted by the pressure of the refrigerant exiting the valve and the superheat spring that are both trying to close the valve. By setting the tension in the superheat spring to the desired superheat, the system is set.

32. If the flow of refrigerant through the valve is restricted due to dirt or debris accumulation on the pin or valve seat, then the evaporator will be starved for refrigerant and the superheat in the refrigerant will increase and the cooling capacity of the evaporator will go down. Sticky debris can also limit movement of the metering pin. If the pin happens to stick in the fully closed position, such that no refrigerant is fed to the evaporator at all, the compressor will shut down due to low suction pressure.

33. High superheat has a number of negative effects. In addition to a loss of performance and cooling capacity, it can result in low pressure in the compressor, which can impact compressor performance and longevity.

34. High superheat from a restricted TXV can also result in what is known as a "frozen coil." A frozen coil can occur, somewhat counter-intuitively, when superheat is too high. As deposits form in the valve and it becomes restricted or begins to stick, the valve cannot respond properly; so when the refrigerant temperature exiting the coil increases, which would normally cause the valve to open more fully, it does not open fully enough and the superheat increases. If restriction across the TXV is great enough that the saturation temperature of the refrigerant drops too low and the localized boiling at the entrance to the evaporator coil is too rapid, then moisture in the household air that is being blown over the coil will condense and freeze on the evaporator coil. A "frozen coil" can be just a layer of frost, although in more extreme cases the evaporator can become encased in ice. In some cases, the ice can cause damage to walls and ceilings when it melts.

35. In Carrier's HVAC systems at issue in this lawsuit, the target superheat is about 10 degrees, although as low as 2 degrees and as high as 20 degrees are considered acceptable by Carrier. In its testing, Carrier considered anything above 20 degrees superheat abnormal.

36. The HVAC systems at issue in this lawsuit come in different size ranges, which are referred to by "tonnage." Relevant here, Carrier manufactured systems in 1.5, 2, 2.5, 3, 3.5, 4, and 5 ton sizes, ranging from smaller to larger, respectively.

V. THE PRESENCE OF RYCONOX IN THE HVAC SYSTEMS IS A SERIOUS, MATERIAL DEFECT

37. Beginning in November 2013, Emerson Hermetic Motors ("EHM") began using Ryconox 20M rust inhibitor on certain components of motors that were installed in Copeland Scroll Compressors manufactured by its affiliated company, Emerson. The rust inhibitor serves no purpose in an installed HVAC system. Rather, its purpose is merely to protect the motor parts during storage and shipment. Emerson sold these Copeland Scroll Compressors to Carrier and to many other manufacturers of HVAC systems. Carrier then installed the Ryconox-containing compressors in over 1 million residential and light commercial HVAC systems, which were sold to the public.

38. There is no question that the presence of Ryconox in the systems at issue in this lawsuit is a serious, material defect. The evidence is overwhelming.

39. Ryconox is known in the industry to cause sticky deposits to form on TXVs, which results in high superheat, low suction pressure, and loss of performance. In fact, according to documents produced by Carrier and Emerson, it

appears that every manufacturer in the industry who utilized Ryconox compressors experienced similar problems with debris formation on the TXV. [redacted]

40. Carrier has never approved the use of Ryconox in its HVAC systems, as confirmed by Carrier's designee. [redacted] Carrier continued to sell its own inventory of Ryconox-containing HVAC systems to consumers.

41. Emerson discontinued the use of Ryconox in or around September 2014 [redacted].

42. As discussed in more detail below, the rate of acute TXV failures (*i.e.*, failures that result in a "no cooling" complaint) due to Ryconox is extremely high, and constitutes an Epidemic failure rate. Even that extremely high failure rate significantly understates the real impact of Ryconox, however, because most systems containing Ryconox have or will suffer performance declines even though the consumer may not be aware of a performance loss. In addition, once Ryconox spreads through the system, it is difficult and burdensome to fully remove it, as evidenced by the TXV repeat-failure rate, even after a TXV is changed or Zerol Ice injected.

43. By at least spring of 2014, Carrier was aware of an increase in the number of TXV failures occurring in recently installed units. The problem was sufficiently significant that Carrier undertook an in-depth investigation to determine the root cause.

44. A "Technical White Paper" produced by Carrier dated August 11, 2014, clearly identifies Ryconox as the root cause of the TXV failure rate increase. Carrier found "a sticky amber colored substance" was collecting in the TXVs causing the TXVs to malfunction and resulting in excessive superheat and non-functioning evaporator coils. Carrier's study demonstrated "conclusively that the root cause of the TXV contamination was ECT's (Emerson Climate Technology's) use, beginning in

November 2013 (in the Reynosa motor facility) of a rust inhibitor called Ryconox 20M in its rotor/stator assembly process." (CARRIER_0020665).

45. Carrier's internal communications reflect Carrier's conclusion that the Ryconox, which was used on the motor of the compressor, is miscible in the refrigerant (meaning it mixes and travels with the refrigerant), and deposits on the TXV during the refrigerant phase change at the TXV. (CARRIER_0018462). It is worth noting that, for the vast majority of the affected units, Emerson used Ryconox on both the rotor and stator of the compressor motor and that refrigerant and oil mix with the Ryconox during operation of the compressor.

46. In addition to high superheat and loss of performance, Carrier also admitted that restriction of the TXV due to Ryconox presents a risk of long-term damage to the compressor. As explained by Carrier's designee, "anytime you have refrigerant not flowing correctly, it's a risk to . . . the compressor and other parts of the system."

47. As explained by Carrier's designee, Carrier's testing focused primarily on identifying and confirming that Ryconox was the root cause of the increase in TXV failures. Thus, its testing utilized "extreme conditions" to recreate the failure quickly and focused primarily on 2 ton units since those tended to fail fastest. (Kafura Deposition, at pp. 57, 58, 65, 247). Carrier's testing on smaller and larger systems was limited.

48. Nevertheless, Carrier's "extreme conditions" testing showed a nearly [redacted] failure rate. Carrier saw a failure, defined as greater than 20 degrees superheat, in [redacted] tests reported in the White Paper. Later, Carrier reported to Emerson that its testing results showed [redacted] systems manufactured in its Collierville plant with Ryconox compressors experienced high superheat within 24 hours under its extreme test conditions for an [redacted] failure rate. Further, while Carrier's early testing showed that its Mexico-built units did not initially show superheat drift, these units also developed high superheat after a lengthier time in Carrier's tests. Carrier determined that another process chemical used by the Collierville plant (called Mobilcut) served to accelerate the formation of TXV deposits but that Mexico units nonetheless developed the same problems with longer run time.

49. Internally, Carrier's Quality Council referred to the Ryconox defect as a "Significant Escape," which Carrier's designee explained "can mean [a defect]" as well as "anything that ultimately doesn't meet a customer expectation." (Kafura Deposition Ex. 14 and Transcript at pp. 112-13).

50. As early as July 2014, in its discussions with one TXV manufacturer, Carrier projected a possible [redacted] failure rate. (CARRIER_0007135).

51. By September 2014, Carrier internally projected a [redacted] incremental increase in TXV warranty claims due to the Ryconox defect in 2 to 2.5 ton systems (*i.e.*, [redacted] more than the normal baseline amount of TXV claims). (CARRIER_0005462).

Ryconox Caused A Failure Epidemic

52. [redacted]

53. After Carrier "conclusively" determined that Ryconox was the root cause of TXV failures as set forth in the White Paper, in September 2014, [redacted].

54. [redacted].[3]

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[3] [redacted].

55. [redacted]. Carrier was experiencing significant pressure from field representatives to approve the use of the additive in part because it is much easier to inject the additive than to replace a TXV and because many of Carrier's competitors approved the use of the additive before Carrier did. [redacted]

56. [redacted]

57. [redacted]

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[4] Zerol Ice and A/C Renew are the same product, manufactured by Shrieve Chemical Products ("Shrieve"). Shrieve sells some of the product to another company, called Nu-Calgon, which re-labels and markets it as A/C Renew. I use the term Zerol Ice, but both products are the same.

[redacted]

58. [redacted]. As explained by Carrier's designee, the historical baseline rate included many different causes of TXV failure, such as defective TXVs and other issues, not just failures due to debris. [redacted] Carrier's baseline first-year failure rate was [redacted] parts per million (PPM), which is the same as [redacted], or about [redacted] percent.

59. [redacted]. This represents a roughly [redacted] failure rate, and most of those systems have been in service for less than four years.

60. A May 19, 2016 article entitled "Appliance & HVAC Warranty Report" in a Warranty Week newsletter showed that United Technologies Corp.'s overall warranty claims and accrual rates from 2012-2015 ran between 0.5 and 1.0%. The same article showed that for the entire HVAC industry those same rates averaged between 0.6 and 0.85% from 2012-2015. (Warranty Week, *Appliance & HVAC Warranty Report* (May 19, 2016), www.warrantyweek.com/archive/ww20160519.html). These data show that the post-Ryconox TXV claims rate is extraordinary and extremely high.

61. Plaintiffs' counsel analyzed the claims data [redacted] and have informed me that, using the claims data [redacted], they estimate that approximately [redacted] of the claims occurred within the first year after installation.[5] That means at least about [redacted] of the total 1.5-2.5 units covered by the bulletins failed within the first year after installation, which is [redacted] more than Carrier's [redacted] baseline first-year historical rate. Further, the baseline included TXV failures from any cause (such as bad TXVs). If the baseline were

[5] The date of installation and date of failure are available for most, but not all, claims [redacted]. For claims reflecting both dates, about [redacted] of the failures occurred within the first year.

limited to debris-related failures, the increase in TXV failures caused by Ryconox debris would almost certainly be more than [redacted] times the baseline.

62. Further, as discussed more fully below, these claims rates understate the true impact of the Ryconox defect. The presence of Ryconox constitutes a serious defect in all of the systems, even if a TXV claim has not been submitted to Carrier yet. And, Carrier's internal documents show that Carrier believed the bulletins would get only a [redacted] If only [redacted] of acute failures were included in the claims, then the total acute failure rate is about [redacted], which lines up almost perfectly with Carrier's projected [redacted] failure rate.

63. Given these facts, and the facts discussed below, there is no question that the presence of Ryconox constitutes a material defect. Indeed, an internal Carrier document discussing the Ryoncox issue asserts "these are material defects." (Kafura Ex. 57). Moreover, given what is known about Ryconox, its propensity to develop debris, and extremely high failure rate, all of the systems containing Ryconox are defective – even if a claim for an acute TXV failure has not yet been submitted to Carrier.

VI. ALL CARRIER HVAC SYSTEMS CONTAINING RYCONOX ARE DEFECTIVE, EVEN IF A TXV FAILURE HAS NOT BEEN REPORTED TO CARRIER

64. Carrier admits in the White paper that "***all*** outdoor split systems, Small Packaged Units, and Light Commercial units manufactured since November, 2013 with [Emerson] compressors are at potential risk of exhibiting [TXV debris and high superheat]." (Emphasis added.) The fact that a TXV failure has not been reported to Carrier does not mean a system containing Ryconox is non-defective.

65. Carrier's claims records show an [redacted] greater chance of acute TXV failure in the first year alone with Ryconox, as compared to Carrier's baseline TXV failure rate.[6] [redacted] When later year failures are included, the TXV

[6] Carrier's baseline TXV failure rate includes failures due to a large number of causes, not just debris. For example, included in the baseline rate are manufacturing defects with the TXV itself, installation issues, and other problems with the TXV that are not caused by debris formation. The baseline rate of failure due to debris formation in the TXV is therefore actually much lower than [redacted], meaning that the impact of Ryconox is even greater by comparison.

claims rate jumps to roughly [redacted] in less than four years, and this is almost certainly only a fraction of the real total impact of Ryconox since, as Carrier documents reflect, for various reasons not all failures are reported to Carrier. Carrier projected a roughly [redacted] failure rate for 2 to 2.5 ton systems.

66. These are extremely high failure rates, but in reality they understate the actual impact of Ryconox. In reality, all or virtually all, of the units containing Ryconox have, or will likely, suffer performance losses due to Ryconox deposits, even though most consumers may not know it until the TXV debris reaches a critical level and they experience a very significant loss of performance.

67. In Carrier's own accelerated testing, virtually every HVAC system experienced a high superheat condition, even though some systems took the accelerated equivalent of 2 to 6 years to manifest high superheat conditions. Carrier's testing of 2 and 2.5 ton units demonstrated that, while the time to failure varied based on the system size, all (or nearly all) systems were affected. For example, Carrier determined that units manufactured in its Collierville facility demonstrated acute failure with about 1 day of testing in extreme conditions, whereas Mexico-built units demonstrated failures after about 16-25 days. Carrier's test team "estimated that 16 days of their teat [sic] equals 2-4 years in service." (CARRIER_0020950). So, 25 days of testing would equate to about 3-6 years. Carrier's testing demonstrates that time to acute failure can vary widely even though failures eventually occur.

68. Many of the units sold to consumers have been in service for less than four years. There is no question that acute TXV failures due to Ryconox will continue for years to come. Additionally, while Carrier's testing was limited primarily to 2 and 2.5 ton systems, the fundamental defect is the same in all systems. Larger systems may take longer to manifest acute TXV failures, but there is no question that Ryconox is impacting them, as discussed more fully in the following section.

69. Critically, there is an ample amount of Ryconox in the systems to cause a future failure, even after a TXV is changed out. As noted above, Ryconox is miscible in the refrigerant and deposits on the TXV during the refrigerant phase change that occurs as the TXV release pressure on the refrigerant. [redacted]

[redacted] That means the vast majority of the Ryconox remains in the system even after an initial failure.

70. In many, if not most instances, consumers do not know that their HVAC systems are impacted by Ryocnox deposits on the TXV. This conclusion is amply supported by Carrier's own documents, a study of a random sample of Ryconox systems performed by one of Carrier's competitors, and by virtue of the basic nature of the debris formation.

71. There is no question that Carrier consumers have experienced high superheat without knowing it. For example, Carrier's warranty data includes examples of instances where service technicians discovered high superheat due to Ryconox during routine maintenance even though the consumer never apparently complained about a loss of performance. In most of these instances, the high superheat was resolved after injection of Zerol Ice, which demonstrates that Ryconox was almost surely the cause.

72. As soon as superheat rises above the target level, unit capacity and efficiency begin to suffer. The ideal superheat is one that is as low as possible but sufficiently high so that no liquid refrigerant can return to the compressor. Carrier's manuals state that superheat below 2 degrees is too low. As Carrier's designee testified, Carrier recommends (or targets) 10 degrees superheat, although up to 20 degrees is considered acceptable under Carrier's service manuals. Any increase in superheat results in a lower cooling capacity, however. Thus, as Carrier's designee also admitted, anything above the target of 10 degrees results in lower performance than Carrier's target, and, as reflected in Carrier's testing and product manuals, anything above 20 degrees is considered by Carrier to be unacceptable.

73. [redacted]

74. In Carrier's accelerated testing under extreme conditions, most systems experienced 30 degree or higher superheat temperatures. That testing was not performed under real-world conditions, however, because the purpose was merely to verify the cause of the TXV debris. Carrier's testing documents acknowledge that anything above 20 degrees superheat "poses a potential for low cooling capacity and potential customer complaints of 'no cooling.'

75. In the real world, a consumer may not notice when a performance decline has occurred with 25 degree superheat, 30 degree superheat, or even higher superheat levels. This is particularly true in the situation presented here where: (1) consumers have purchased a new system and do not have a long record of historical performance to compare it against; and (2) performance declines can happen gradually as more and more debris forms on the TXV over time.[7] Carrier's own testing demonstrated that there was wide variety in how quickly debris formed on 2 versus 2.5 ton units and also between Collierville-built and Mexico-built units, but Carrier nonetheless concluded that the debris eventually formed on them all. Moreover, while Carrier initially believed that 1.5 ton systems were not experiencing increased acute failure rates, over time those systems began showing "very large" increases in warranty claims too. (CARRIER_0005492).

76. Carrier never attempted to determine whether consumers who have not suffered acute failure (*i.e.*, complained about a lack of cooling) may be experiencing performance declines according to Carrier's designee. Rather, the purpose of Carrier's testing was only to quickly identify and confirm Ryconox as the cause of acute TXV failures. As such, Carrier's testing primarily focused on 2 ton units which tended to demonstrate the failure most quickly. While Carrier did some early tests of 2.5 ton and larger units, which were also experiencing field reports of TXV failure, it quickly ceased these tests when it determined that the problem was quickest to manifest in 2 ton units. Moreover, Carrier's testing, as Carrier's designee pointed out, was performed under "extreme conditions" that the systems do not "normally see in the field." Nevertheless, Carrier's designee admitted that partial restrictions resulted in increased superheat in its tests when a complete failure had not yet occurred. Carrier's designee also admitted that Carrier has never attempted to test whether or what percentage of its consumers are experiencing performance declines in the real world.

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[7] In addition, Plaintiffs allege that Carrier never disclosed the defect to consumers, so consumers would have no reason to suspect or check for a performance decline. In fact, Carrier labeled its service bulletins "Confidential and Proprietary Information – Not for Further Distribution" in order to prevent them from being posted on the internet because, as Carrier's designee testified, Carrier was concerned that its competitors might use the bulletin to compete against Carrier.

77. [redacted]. [redacted]

78. Indeed, Carrier employees have acknowledged that debris formation can occur over time and that customers may not notice. Wayne Varner, one of Carrier's Technical Service Managers, acknowledged in an email concerning TXV failures that "units that were run primarily in a full load conditions [sic] tended to exhibit the issue more quickly that [sic] units that cycled during lower loads," and further admitted that "it is possible that these units began to have symptoms . . . at levels the homeowners' could not feel." (CARRIER_0023057).

79. Similarly, Carrier has acknowledged that it saw a "significant increase" in TXV claims rates for 2, 2.5, and 3 ton packaged units (CARRIER_0043246), even though it never released a bulletin covering these units. [redacted]

80. Finally, given that Ryconox is known in the industry to cause sticky deposits and TXV failures, virtually no manufacturer of residential or light commercial HVAC equipment would accept a compressor containing Ryconox today. [redacted]. There is no real question that the presence of Ryconox constitutes a defect, even if it has not manifested in an acute failure yet.

VII. ALL 1.5 TO 5 TON SYSTEMS ARE DEFECTIVE.

81. There is also no question that the presence of Ryconox constitutes a material defect in 3-5 ton systems, as well as 1.5-2.5 ton systems. Carrier's bulletins are limited to 1.5 to 2.5 ton units, but in reality, all 1.5 to 5 ton units containing Ryconox are defective due to the presence of Ryconox. Carrier's own internal documents acknowledge that Ryconox affects 3-5 ton systems. Likewise, reports from the field, [redacted], and examination of the means by which Ryconox deposits on TXV pins shows that 3 to 5 ton systems are affected by the Ryocnox defect, along with 1.5 to 2.5 ton systems.

82. Numerous Carrier internal documents admit that the Ryconox issue is not limited to 1.5 to 2.5 ton systems. Carrier received reports from home builders, dealers, and distributors alike concerning Ryconox-related TXV failures on 3 to 5 ton systems, [redacted]. In some cases, Carrier's material group "confirmed" sticking TXVs on 3 to 5 ton units from Ryconox. (CARRIER_0020740). Even Carrier's White Paper referencing the "total affected ECT compressors" includes 3 to 5 ton units. And, as noted above, Carrier's internal documents also acknowledge a "significant increase" in TXV claiming for 3 ton packaged units, even though these units were never covered by any Carrier bulletin.

83. Internal documents show that Carrier believed the variation in the incidence of acute TXV failures caused by Ryconox in different size systems was not because the presence of Ryocnox was not a problem in larger units but instead because "[r]efrigerant volume, ambient conditions, and TXV valve capacity" influenced the impact of debris and the manifestation of acute TXV failures. (CARRIER_0005532). Nevertheless, Carrier acknowledged that "long term reliability may be impacted" in all sizes of system containing the Ryconox compressors. (CARRIER_0011452) [redacted]

84. That the Ryconox is more dilute does not mean that 3 to 5 ton systems containing Ryconox are not defective, however, nor does it mean that debris has not or will not form on the TXVs of these units resulting in performance loss. Rather, it simply means that it may take a longer time for the most noticeable effects to occur.

Based on the underlying mechanism of debris formation, there is undoubtedly debris that has and will form on the TXVs of these 3 to 5 ton units, and the larger size simply means it will take longer for consumers to notice performance declines, which will likely happen over a longer time with these systems.

85. In fact, in June 2015, long after Carrier saw significant TXV claims for smaller units, David Meyers, President of Carrier Enterprise (a Carrier-affiliated distributor) reported that "[t]he amount of emails and issues on TXVs is going through the roof . . . lots of energy around 3 and 3.5 ton units . . . the picture is changing." (CARRIER_0028578).

86. One set of Carrier's testing data showed that 2.5 ton units took 4 times as long to fail as a 2 ton unit in lab testing (about four days versus one for the 2 ton systems). And, as noted above, Carrier-Mexico units took 16-25 times as long to fail in certain tests than Carrier-Collierville units. This demonstrates that the size of the unit (along with other factors, such as the presence of accelerants like Mobilcut) can affect the time to failure. Of course, that does not mean that 2.5 ton systems are any less defective than 2 ton systems, or that Carrier-Collierville units are more defective than Carrier-Mexico units. Consistently, 3 to 5 ton systems containing Ryconox are just as defective as 2 and 2.5 ton systems even though they may manifest symptoms later or differently.

87. There is more than enough Ryconox on the motor to cause impacts in the 3 to 5 tons systems. [redacted]

88. In fact, internal correspondence in August 2014 confirms that, even by that early time period, the Ryconox issue had "been reported and verified . . . on other tonnage units," and "[b]ased on the root cause testing . . . all Copeland compressors for residential and Light Commercial are at risk for creating this issue with the TXV." (CARRIER_0018461).

89. Many of Carrier's largest distributors reported Ryconox-related failures on 3 to 5 ton unit, as well, and complained that carrier had not included them on the bulletin. A representative from one of Carrier's top distributors commented: "Can someone from Carrier absolutely, positively state there are no issues outside the

bulletin[?] I beg to differ. We might need to do a field visit together." (CARRIER_0014682).

90. Another Carrier document, referencing "TXV Contamination Speaking Points," also shows that Carrier "recognize[d] TXV contamination can occur in 3+ ton units," [redacted] (CARRIER_0005285).

91. Given the known causation and mechanism of debris formation from Ryconox, there is no question that 3 to 5 ton systems containing Ryconox are also defective.

92. While Carrier claims that it has not seen a significant increase in warranty claims for 3 to 5 ton units containing Ryconox, there are many reasons why Carrier's warranty rate may not accurately reflect the real failure rate of 3 to 5 ton systems due to Ryconox.

93. First, Carrier never issued a bulletin for 3 to 5 tons systems. For 1.5 to 2.5 ton systems, Carrier issued a bulletin instructing distributors and service technicians on the procedure to repair stuck TXVs on units within that defined population. Carrier provided a process for submitting claims for labor reimbursement [redacted]. For later bulletins, this required the outdoor unit serial number so that Carrier [redacted] could confirm that the affected unit contained Ryconox. No similar bulletin was ever released for 3 to 5 ton systems, and no similar process was established by Carrier to track 3 to 5 ton claims by outdoor serial number. Carrier never created a claims process for 3-5 ton systems, so it is likely that TXV issues caused by Ryconox in 3 to 5 ton systems are simply underreported to Carrier.

94. Relatedly, as Carrier admits, only about [redacted] of consumers register their warranty. So, consumers with 3 to 5 ton systems who experience a TXV failure may never submit warranty claims. This is particularly likely since Carrier never agreed to pay labor costs for repairs of 3 to 5 ton systems, which would encourage claim submission. Carrier's standard warranty covers only parts, not labor or materials, and the cost of a TXV is relatively modest compared to the cost of the non-

reimbursable labor and materials required for a TXV change. It is likely that many TXV issues simply go unreported to Carrier.

95. Carrier also admits that its warranty system is not set up to accurately track these failures. Specifically, when a claim for a TXV issue comes through Carrier's warranty system, only the serial number of the indoor unit is required, since the TXV is located on the indoor unit. Indoor and outdoor units are sold separately. So, knowing the serial number and manufacture date of the indoor unit says little or nothing about the serial number and manufacture date of the outdoor unit. For example, an indoor unit that was manufactured in 2015 (after Carrier stopped using Ryconox compressors) could be mated to an outdoor unit manufactured in 2014 with Ryconox. The only way an indoor unit serial number can be linked to an outdoor unit serial number is if Carrier's warranty registration data contains both serial numbers. However, the vast majority of system warranties are not registered.

96. Carrier also contradicted its own position when Emerson tried to use Carrier's warranty data to show that Carrier's Mexico-manufactured units were not affected by the Ryconox issue. Carrier argued to Emerson that, for most of the data, any attempt to match indoor and outdoor units can occur only based on registration address, which "does not conclusively link a specific indoor serial to an outdoor serial." Carrier further pointed out that "[m]any of the records have multiple indoor or multiple outdoor units registered to the same address making it impossible to determine a 1 to 1 match of indoor to outdoor." (CARRIER_0005494). Carrier concluded, "Integrity of this data set is fundamentally flawed for determining conclusive OD to ID system match." Carrier cannot credibly take the position that the warranty data captures all of the failures, as it took the exact opposite position in its dealings with Emerson by claiming that the data was "fundamentally flawed" with respect to attempting to match indoor and outdoor units. Therefore, Carrier's present claim that it has not seen an increase in 3 to 5 ton claims rates is not credible.

97. Nor does Carrier have any incentive to confirm that there is a high rate of Ryconox-related failures on 3 to 5 ton systems [redacted].

98. As Carrier knew, many other major HVAC manufacturers' Ryconox bulletins subsequently covered units greater than 2.5 tons and provide

reimbursement for repairs on these systems. These systems utilize the same or similar compressors as Carrier systems and the same or similar TXVs as Carrier systems.[8]

99. In short, there is no question that the presence of Ryconox in 3 to 5 ton systems constitutes a material defect, just as the presence of Ryconox constitutes a material defect in 1.5 to 2.5 ton systems. There is nothing fundamentally different about 3 to 5 ton systems that renders them immune to Ryconox.

100. Finally, I am informed by Plaintiffs' counsel that Carrier has agreed to produce TXV claim data for 3 to 5 ton systems, but that Carrier has yet to produce such data. Accordingly, I specifically reserve my right to supplement this opinion after that data has been produced.

VIII. THE COST TO REMOVE OR REMEDIATE RYCONOX AT THE TIME OF PURCHASE CAN BE DETERMINED ON A CLASS-WIDE BASIS:

101. I have been asked by Plaintiffs' counsel to opine as to the cost to repair the defective HVAC units at the time of purchase as a means of calculating class-wide economic damages arising from the alleged omissions. In other words, what would it cost a consumer to repair the product at the time of purchase in order to remove or remediate the Ryconox defect? As set forth more fully below, I calculate the average cost to repair or remediate Ryconox contamination using two models.

102. The first model assumes that the Ryconox defect can be remediated by injecting Zerol Ice as a preventative and calculates the average cost to consumers to obtain such injections in the market. Carrier claims that Zerol Ice is an effective preventative for the Ryconox defect, but it declined to provide preventative injections due to cost and supply concerns, among other reasons. As set forth below, in reality, Zerol Ice causes harm and creates new risks, even though the evidence shows it to be effective at preventing Ryconox TXV clogs. Nevertheless, since Carrier admits that Zerol Ice is an effective preventative, and further claims that it is safe, Plaintiffs' counsel asked me to calculate this amount as a floor for estimating economic damages from Carrier's failure to disclose the Ryconox defect.

[8] Carrier did not manufacture its own TXVs. Instead, it purchased them from companies that also sell to Carrier's competitors.

103. The second model proceeds based on the reality that, as demonstrated below, injecting Zerol Ice is harmful to the HVAC systems, and, therefore, it does not constitute an adequate remediation of the Ryconox defect. Swapping one defect for another at the time of purchase would not provide a consumer with a defect-free system. Under the second model, I calculate the average cost to consumers to remove Ryconox from their systems at the time of purchase, which essentially requires replacing the Ryconox-contaminated compressor before the system is run. Obviously, once a consumer runs his or her HVAC system for any length of time, the Ryconox spreads beyond the compressor and therefore replacing a compressor *now*, after the systems have been run, will not remove Ryconox. So, the purpose of this model is not to determine the cost to remove Ryconox now. Rather, Class Counsel asked me to calculate what it would cost to render the product defect-free *at the time of purchase* as a measure of economic damages, or the amount by which consumers overpaid due to the defect.

104. For purposes of both models, it is helpful at the outset to understand some basic points about the manner in which the HVAC service industry operates.

a) First, any HVAC service company (even if it is operated by a single individual) has overhead costs, such as the costs of trucks, tools, equipment, back-office support, advertising, insurance, etc. Thus, in order to be profitable, service companies must charge enough for service calls to cover not only their time performing the service but also a portion of their overhead.

b) Second, it is common in the industry to charge a flat rate for service calls (*i.e.*, the basic cost to come to a customer's home for any purpose) and also to charge for service based on hourly rates. Both service charges and hourly rates must cover the time necessary to come to the customer's home and perform the service but also must cover a portion of overhead and also provide for some profit.[9]

105. Many, if not most, major HVAC manufacturers provide labor reimbursements under specified circumstances, such as for warranty coverage. Further, many, if not most, reimburse labor based on a single hourly reimbursement rate, which does not vary geographically. For example, [redacted] Moreover,

[9] Many HVAC service companies charge flat rate pricing based on the specific service to be performed. Even flat rate pricing, however, is based on the average amount of time to perform a particular service times an hourly rate.

virtually all (if not all) of the bulletins related to the Ryoconox issue utilized a standard, nationwide reimbursement rate as well. Thus, it is common in the industry to utilize nationwide reimbursement rates.

106. According to Carrier's designee, during the time frame at issue here, Carrier reimbursed labor at [redacted] per hour, which Carrier determined to be an average national hourly rate. Carrier's designee explained that "we have historical records in our warranty database," and "we take … an average across – across all the warranty claims to establish an average national rate." Consistent with other manufacturers in the industry, Carrier's hourly labor rate did not vary by geographic region. Carrier's designee also indicated that Carrier based its early bulletin TXV replacement reimbursement rates on this [redacted] per hour rate times three hours.

107. I believe Carrier's [redacted] per hour national average rate is somewhat low. [redacted]. Carrier's designee likewise explained that the [redacted] reimbursement rate was derived [redacted] Also, Carrier's own informal data gathering in 2014, in the Mid-Atlantic and Memphis regions, reflected an average hourly rate of [redacted] per hour. In fact, after conducting this study of real-world rates, Carrier increased is labor reimbursement rates for TXV replacements to $400 which equated to $133 per hour based on Carrier's estimated 3 hours of labor required to replace a TXV.

108. Also, I have reviewed a 2005 Basic Hourly Charge Out Service Rate survey published by the ACHR News, a widely read and highly respected industry publication. This survey, based on 173 responses from across the country, showed a mean hourly rate of about $70 in 2005. Applying year by year inflation rates based on the CPI, this mean would have been just under $85/hour in 2014 and almost $89/hour in 2017.

109. Moreover, I have examined Carrier's 2008 "Dealer Program Guide" for Carrier's Optional Warranty Program, which is an optional warranty program sold to consumers by Carrier's dealers that does provide for labor reimbursement. Under the Optional Warranty Program, Carrier offered four hourly reimbursement rate levels: $75, $90, $110, or $130 per hour. The average of these rates is $101.25 per hour and the midpoint is $102.50. Further, under the program these rates automatically increase 5% every three years to adjust for inflation. Using Carrier's own inflation rate, the lowest rate of $75 per hour in 2008 would be $82.69 in 2014, and the midpoint would be $113 in 2014.

110. Nevertheless, while Carrier's [redacted] national average rate is somewhat low, Plaintiffs' counsel have asked me to adopt Carrier's [redacted] national reimbursement rate to ensure that my estimates are conservative. Moreover, it is appropriate to utilize this rate on a national basis, since reimbursing based on a national average labor rate is common in the HVAC industry, and since Carrier actually applied this rate on a nationwide basis during the relevant time.

111. Further, Class Counsel have asked me to assume that the only service charges are hourly rates, and to ignore the common industry practice of charging a separate service call fee.

112. Finally, service companies also typically mark-up the price of any supplies or materials needed for the job above the prices charged by their local distributor. For example, one of Carrier's Extended Warranty program guides for its dealers allowed a 70% markup on parts through the extended warranty program. Based on my research, mark-ups of 50-70% are common. This point is relevant below with respect to the cost of Zerol Ice itself.

A. FIRST MODEL - PREVENTATIVE INJECTION OF ZEROL ICE:

113. At the very least, if the defect had been disclosed, consumers could have have mitigated the effects of the Ryconox defect by obtaining preventative injections of Zerol Ice.

114. Carrier knew that Ryconox causes debris and loss of performance, and Carrier believed that Zerol Ice was an effective preventative. In fact, Carrier seriously considered providing labor and parts reimbursement for preventative injections of Zerol Ice for all affected units and even drafted a bulletin providing for preventative injections, but Carrier ultimately decided not to provide preventative injections, not due to a lack of effectiveness, but rather due to [redacted], and concerns over an inadequate supply of Zerol Ice, among other reasons. [redacted].

115. An internal "TXV Contamination Speaking Points" document nevertheless shows that [redacted]. (CARRIER_0005285). Instead of providing preventative applications of Zerol Ice,

which Carrier admitted were effective, Carrier provided reimbursements for injections of Zerol Ice only for consumers who suffered acute failures. As discussed above, the Ryconox defect affects *all* consumers who purchased these units, and all, or virtually all, consumers with Ryconox-containing units have or likely will experience TXV debris due to Ryconox, which causes performance impacts and threatens long-term reliability of the systems, even if the consumer has not noticed an impact.

116. When considering providing a preventative solution to the Ryconox defect, Carrier calculated the cost of providing preventative Zerol Ice injections into 1.5 to 2.5 ton units using a labor rate of $195, plus [redacted] for the additive itself, for a total of [redacted] per unit. That is what Carrier was paying for curative applications of Zerol Ice and would serve as a fair estimate of the cost to consumer to obtain Zerol Ice injections on the open market.

117. Overall, Carrier's calculated reimbursement rate of [redacted] is a reasonable estimate of the actual cost that would be incurred by a consumer for a preventative injection in the open market given the time required to complete a preventative application and accounting for travel time, overhead (including equipment necessary to perform an injection), profit margin, and other factors which would normally be included in the cost of any service.[10]

118. Carrier's assumption of a [redacted] cost for Zerol Ice reflects the wholesale price paid by Carrier not the price that an ordinary consumer would pay, which would typically include additional markup by the distributor and technician. As of the date of this report, distributors' prices for Carrier's part number 040232191046 (which is the only Carrier-approved part number for Zerol Ice) range from around $82 to $100 (without shipping) (www.supplyhouse.com; www.controlscentral.com; www.bakerdist.com). Thus Carrier's [redacted] cost is far below what a typical service technician would pay. Moreover, while some service technicians might pay less than

[10] Carrier's $195 labor rate is not a reasonable average for a *corrective* application of Zerol Ice, however, since, as reflected in Carrier's bulletin, corrective applications require: (1) diagnostic time and checks for refrigerant charge, static pressure, air flow, and correct coil size and orientation; (2) cycling of the valve to ensure that the Zerol Ice can flow through the system; and (3) confirmation that the Zerol Ice was effective at correcting the high superheat condition, which may require a return visit in addition to travel time.

$82, they would also mark-up the price of the part to the consumer. Just as an example, one of the Plaintiffs (Mr. Klinge) who paid out-of-pocket for Zerol Ice injection was charged $117 for the bottle of Zerol Ice. Another Plaintiff (Mr. Oddo) acquired Zerol Ice directly from a distributor for $89.22, which did not include any dealer markup. In order to be conservative, I assume an average cost to the consumer of $85 for the part itself. This is more representative of a distributor's price, not the part cost to a consumer who hires a technician to inject Zerol Ice, and therefore it is a very conservative amount.

119. While Carrier's [redacted] cost for the additive is low, however, I estimate that the service (or labor) cost to hire a technician to inject Zerol Ice as a preventative measure would be, on average, slightly less than Carrier's calculated $195 labor reimbursement. Injecting Zerol Ice as preventative is not as labor-intensive as injecting Zerol Ice as a curative.

120. Carrier's designee testified that, under the bulletins, Carrier reimbursed for curative injection of Zerol Ice based on an assumption of roughly 2.5 hours of labor (times [redacted] per hour). Curative application requires additional time, however, since it requires exercising the valve and performing follow-up performance checks to ensure that a clog has been cleared.

121. Carrier's Director of Quality, Christine Rath, recommended a $100 labor reimbursement rate for preventative injections to be performed at the time of installation of the HVAC system and estimated that injection of Zerol Ice at the time of installation would take an additional 30-45 minutes. However, that estimate assumes a technician who is already on-site and has a supply of Zerol Ice (*i.e.*, does not require a trip to the supply house). Thus, her estimate is lower than the cost that a consumer would incur to hire a service technician to come to his or her home to perform a preventative injection.

122. [redacted] Again, however, this rate assumed that the technician was already on-site to install the condensing unit and had a supply of Zerol Ice, and, therefore, would not cover the cost a consumer would incur to hire a technician to come to his or her house solely for the purpose of injecting Zerol Ice.

123. On balance, I believe Carrier's total estimate of [redacted], which it utilized when performing a total cost estimate for preventative application of Zerol Ice, is a fair and reasonable of the average costs to consumers for preventative injections, although I base this on a higher part cost and lower service charge. ([redacted] Mr. Klinge paid out-of-pocket for a Zerol Ice injection, consisting of $117 for the Zerol Ice itself and $109 in service/labor charges.)

124. In order to ensure an extremely conservative estimate, however, I calculate a lower total cost of $150 for preventative application of Zerol Ice, consisting of $85 for the part and $65 in labor. This is supported by many facts.

125. Most manufacturers reimbursed at least $150 in *labor alone* for Zerol Ice injections, which did not include the cost of Zerol Ice itself. Carrier and a few others reimbursed slightly more, up to $195 for labor. Given that these reimbursements were paid almost industry-wide, it is fair to say that $150 for labor is the minimum "going rate" in the industry for performing this service. In other words, it is safe to say that the vast majority of Zerol Ice injections performed on the market since 2014 have been at a labor rate of $150 or more.

126. As such my $150 total for both labor and Zerol Ice is realistically below the average that it would cost a consumer to obtain a preventative application of Zerol Ice in the market. For purposes of creating a class-wide damages model, however, it is reasonable, if not overly conservative.

127. This estimate also aligns with Christine Rath's estimate that injecting Zerol Ice as a preventative during installation would take 30-45 minutes of time multiplied by Carrier's [redacted] per hour nationwide average labor rate. Since I estimate an average retail price of $85 for the Zerol Ice itself, that means $65 of the $150 total estimate represents labor. [redacted]. This aligns almost perfectly with Christine Rath's estimate that injection of Zerol Ice at the time of installation would take an additional 30-45 minutes. And, again, Christine Rath's estimate assumed a technician who is already on site. In reality, a consumer seeking to have this service performed in the market would need to hire a technician to come out, who would have travel, overhead, and other costs built in to the price.

128. Applying this amount to the class is then a matter of simple math: $150 times the number of units in the class.[11]

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[11] Some class members may have already had injections of Zerol Ice due to acute failures of their systems. This does not mean they have no damages under this

129. I understand that Plaintiffs have not yet filed a motion for class certification. No matter what population of units is ultimately included in the class, however, this damages model can be applied on a class-wide basis simply by multiplying the $150 amount times the number of units in the class. I understand that Carrier maintains complete records identifying the serial number of each compressor in all of the relevant HVAC systems, and so it should be relatively simple to perform a reasonably accurate count of the class units once the class is defined.

130. As discussed, Plaintiffs' counsel asked me to determine a conservative average cost to inject Zerol Ice as a measurement of their economic damages at the time of purchase. However, it also serves as a realistic (albeit conservative) cost amount for class members who might presently seek to mitigate the Ryconox defect by obtaining a Zerol Ice application for their system, although I do not recommend such injections.

B. SECOND MODEL – THE COST TO REMOVE RYCONOX FROM AFFFECTED SYSTEMS AT THE TIME OF PURCHASE:

131. As discussed further below, while injecting Zerol Ice prevents Ryconox deposits, the evidence shows that Zerol Ice is also harmful to the HVAC systems. Accordingly, in reality, the cost of injecting Zerol Ice as a preventative is not fully compensatory. Therefore, in the alternative, Plaintiffs' Counsel have also asked me to calculate the cost of a process that would fully remove Ryconox at the time of purchase.

132. Since the purpose of this calculation is to determine an economic damages amount at the time of purchase (*i.e.*, a measure of the amount by which consumers overpaid for their systems) Plaintiffs' counsel asked me to determine the cost to fully remove Ryconox at the time of purchase *before the unit has been run*. This results in a very conservative calculation because the cost to remove Ryconox prior to running the system is far less than the costs to fully remove Ryconox once the system

model, however. Zerol Ice is harmful, for the reasons discussed below. I understand that Plaintiffs' counsel asked me to calculate the cost of preventative injections solely as a proxy for the minimum floor for economic damages – *i.e.*, a measurement of the amount by which class members overpaid for their systems due to the undisclosed defect.

has run for any appreciable amount of time. That is because, as the system runs, the Ryconox spreads from the compressor to the outdoor coil, through the lineset, to the TXV and indoor coil, and back again, potentially contaminating the entire HVAC system. Fully removing the Ryconox at that point would require a more burdensome process. Again, however, Plaintiffs' counsel has asked me to take the more conservative approach.

133. Prior to operating a system containing Ryconox, the Ryconox is confined to the motor of the compressor. Although Carrier performs run-testing of the outdoor units at the factory, Carrier's designee testified that the Ryconox was not likely to spread during that testing due to the very short run time in the factory. Accordingly, for purposes of this analysis I assume that the Ryconox has not spread beyond the compressor at the time of purchase.

134. The compressors utilized in the class systems are hermetically sealed. They are not meant to be opened or serviced in the field. It is not possible to replace only the motor in the compressor.

135. Accordingly, removing Ryconox from a new system before it has run in the field would require the following steps: (1) recovering refrigerant from the outdoor unit; (2) removing the suction and high side Schrader valve cores; (3) removing the contaminated compressor by disconnecting all electrical wires, unbrazing the suction and discharge lines at the joints closest to the compressor, and unbolting the compressor from the base; (4) installing a new, non-contaminated compressor by bolting the compressor to the base, brazing the suction and discharge lines, and connecting the electrical wiring; (5) replacing the Schrader valve cores and evacuate the unit; and (6) Recharge the unit with refrigerant. Performing this process involves two primary costs: the cost of the part (*i.e.*, the replacement compressor) and the cost of the labor required to perform it.

136. In order to ensure complete removal of Ryconox, a technician actually performing this service would likely use fresh refrigerant rather than the potentially contaminated refrigerant removed from the old compressor. Thus, the real-world cost would also include the cost of replacement refrigerant. Because I assume a system that has not been run, however, which means any mixture of oil, refrigerant, and contaminant has been minimal, I do not include in my calculation any costs for fresh refrigerant.

137. The average time necessary to perform a compressor replacement described above is about 4 hours. This time does not vary materially among the various 1.5 to 5 ton systems at issue in this lawsuit nor does it vary geographically. This estimate of time is supported by many sources, including Carrier's own Optional Warranty program, which provides a 4-hour labor allowance for a compressor change out.

138. Therefore, based on the conservative [redacted] per hour national average labor rate times the number of hours, I calculate the labor component to be [redacted] per unit.

139. With respect to the parts costs (*i.e.*, the compressor itself), Plaintiffs' counsel provided me with a list of the compressor model numbers used in the relevant outdoor 1.5 to 5 ton outdoor units, along with retail prices from multiple sources for each unit. Exhibit D is a price list for the compressors used in the affected units. The list uses multiple sources where available and shows the average price listed on the available sources.[12] I have determined an average price for each model and also calculated that the weighted average across all models is $709. These prices are conservative because they do not include any mark-up by the service technician, which is common.

140. Once again, applying this average cost on a class-wide basis is simple. First, determining the labor component is a simple matter of multiplying [redacted] times the number of units in the class. Similarly, determining the class-wide parts component is also a matter of simple arithmetic.[13] One can multiply the weighted average cost ($709) times the number of units in the class or can examine cost on a model-by-model basis, since Carrier's records include the compressor model number for each unit. Using the weighted average yields an average cost of $1,029 per unit.

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[12] Forty-six compressor model numbers account for around 99% of all compressors used in the relevant units. Another 39 model numbers account for only about 1%. For the less common 39 models, we use the weighted average of the price of the more common models, which is $709.

[13] Alternatively, since Carrier's records include compressor model and serial numbers for all of the relevant units, we can determine precise costs for each affected unit in the class when the class is defined.

141. Because the class is not yet defined, I have not yet tallied the total damages amount. No matter what population is ultimately included in the class, however, this damages model can be applied on a class-wide basis.

IX. INJECTING ZEROL ICE DOES NOT PROVIDE CONSUMERS A DEFECT-FREE HVAC SYSTEM; INSTEAD, IT CAUSES DAMAGE AND CREATES NEW RISKS

142. Prior to October 2014, Carrier's bulletin instructed service technicians who encountered a "frozen furnace coil" (within the models and serial ranges listed) that they should "replace the TXV with a new part/kit at the time of failure."[14] As noted above, however, by September 30, 2014, Carrier [redacted] Carrier would begin instructing technicians to inject Zerol Ice into the systems to remediate the effects of Ryconox deposits rather than replace the TXV. On or around October 23, 2014, Carrier announced that, going forward, "[F]or installed . . . units that . . . exhibit high SH . . . the SOLE solution will be to inject the [Zerol Ice] into the system and exercise the TXV valve."

143. Injecting Zerol Ice does not provide consumers with a defect-free system. While it often addresses the high-superheat symptoms of Ryconox deposits on the TXV, (1) it does not actually remove the Ryocnox from the system; (2) it adds further contaminants into the system; and (3) most importantly, it causes damage, premature wear, and other risks to the system.

144. As I stated above, anything inside an HVAC system other than refrigerant and oil is typically considered a contaminant. Historically, manufacturers have disallowed the use of additives like Zerol Ice. For example, Emerson issued a bulletin in 2007 stating "from our own testing and past experience, the company generally does not recommend use of any additives . . . for any purpose. Furthermore, the long term stability of any additive in the presence of refrigerant, low and high temperatures, and materials commonly found in refrigeration systems is complex and difficult to evaluate without rigorous controlled chemical laboratory testing." Similarly, in an FAQ asking "can I add an additive to the oil in my system?" Emerson answered flatly, "No. Additives are not permitted." (CARRIER_0005894-98)

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[14] Carrier's early bulletins referenced furnace coils, which are indoor units. They did not reference outdoor units, which is where the Ryconox defect originated.

145. Zerol Ice was never intended to resolve the Ryconox defect; it had been marketed as a product that could be used to squeeze a few more months out of an air conditioner that was nearing end of life. A Shrieve representative described Zerol Ice to Carrier as follows: "The principal nature of Zerol ICE is to add EP additives t**o a system nearing the end of life to give an added boost to an aged compressor**. Its commercialization is principally for the stationary aftermarket **where a** [sic] **owner has called the service tech and wants another 3,6,12 months of operation before replacing the unit**." (CARRIER_000003) (emphasis added).

146. Carrier quite rightly questioned the "stability of this product for a newer system that has 15-20 years of life." (CARRIER_000002). In fact, Carrier's internal documents reflect staunch opposition to the use of Zerol Ice, [redacted]. A Technical Information Communication drafted by Carrier around September 4, 2014, concerning the "Use of System Additives to Correct TXV Contamination Issue" noted that, though some field technicians were using Zerol Ice to fix Ryconox clogs, Carrier "**strongly recommend[ed] against** the use of any aftermarket additives," because "these chemicals increase the acidity of the system" and "long-term impact on system reliability is unknown." (Kafura Ex. 61) (emphasis added). The document further explains, "While some of these additives appear to be successful as an immediate fix, our testing shows the fix may be temporary and could cause potential damage to the system." This approach was consistent with conventional wisdom throughout the HVAC industry where traditionally the use of additives has been discouraged because of their potential effects on the system chemistry and component reliability.

147. Numerous other internal Carrier documents also reflect Carrier's knowledge of the harmful effects of Zerol Ice, including that the "higher acidity [of Zerol Ice] attacks certain types of materials used in the system." (CARRIER_0024496).

148. Despite Carrier's healthy skepticism concerning Zerol Ice, and concerns about "long term effects on system reliability," (CARRIER_0018015), Carrier was getting significant pressure from the field to adopt Zerol Ice to address the Ryconox epidemic. One Carrier document noted that "[d]uring the most profitable time of the year, dealers have been forced to allocate resources to replace TXVs on newly installed systems rather than utilize the same resources to do new installs that generate profit." (CARRIER_0006224). TXV replacements are time consuming. Allowing Zerol Ice injections, instead of TXV replacements, would significantly reduce the time that dealers were forced to spend dealing with the Ryconox problem. Some field service technicians were also complaining about repeat failures after replacing the TXV, which is consistent with Emerson's finding that TXV clogs were caused by just a small fraction of the total Ryconox in the systems. By mid-

September many of Carrier's competitors began instructing technicians to inject Zerol Ice, which put further pressure on Carrier to follow the crowd. Another internal Carrier document noted that Carrier was "getting push to return [outdoor] units [that contain Ryconox and] . . . approval of [the] additive could provide an option to avoid this." (CARRIER_0018023).

149. In its September 22, 2014 field status review (CARRIER_0005557), Carrier outlined some of the risks of Zerol Ice, including that it "Contains organic acids," and the "Higher acidity level attacks specific metals," including "lead leaching" from "leaded compressor bearings." It also causes zinc leaching from brass, such as the brass used in TXVs. Carrier also noted that Zerol Ice caused "up to 17% higher than normal swelling of elastomers" such as seals and rings used in the system, and the "neoprene seal in Emerson TXV" saw a 12% greater increase in swelling due to Zerol Ice. Carrier also noted that Zerol Ice caused "copper plating." Copper plating occurs when copper is dissolved from system components, such as copper coils, and redeposits on other surfaces, often ferrous surface (*i.e.*, surfaces containing iron, like steel). After injecting Zerol Ice, Carrier even found copper plating on the TXV pin itself, which concerned Carrier. Carrier also expressed concern that "[m]any field technicians [are] not capable to inject [the] system . . . [and the] [i]njection procedure [itself] is [a] risk for introduction of contaminants."

150. One major problem (among many) with injecting Zerol Ice is harm to the compressor. As Carrier noted, a particular concern was that Zerol Ice could leach lead from the compressor bearings. The compressor is the heart of an air conditioning system, and bearings are essential to the smooth, efficient operation of the compressor. Testing whether Zerol Ice would harm the compressor was critical. Carrier, however, did <u>no</u> testing on the compressor. In fact, Carrier did very little testing at all. Carrier's designee testified that Carrier's testing was primarily limited to: (1) checking whether Zerol Ice was effective as a curative and/or preventative; and (2) conducting material compatibility testing, which essentially involves placing metal or other material samples in test tubes with refrigerant, oil, and Zerol Ice and heating them up to see how they react. Carrier did not perform any long-term run testing with Zerol Ice.

151. Instead, Carrier invited the fox to guard the henhouse by having Emerson perform compressor testing with Zerol Ice. [redacted]

152. Carrier's documents reflect its concerns about the "long term" impact of Zerol Ice. [redacted]

[redacted]

[redacted]

154. [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

- [redacted]

(emphasis added).

155. These results are consistent with many of the problems with Zerol Ice discussed above, including that it causes lead leaching from bearings, the high acidity can attack metals, and also that it can cause degradation of oil. In fact, [redacted] Zerol Ice is an oil additive. It mixes and travels primarily with the oil in the system. As explained by Emerson's designee, the compressor is designed to feed oil to the bearings that are significant load-bearing parts of the compressor. Thus, it should have come as no surprise that Zerol Ice has an impact on the oil and bearings.

156. In addition, [redacted] Heavy copper plating can have a detrimental effect on bearing life and copper plating is an indication of system instability.

157. As Emerson's designee admitted during his deposition in the ClimateMaster case, [redacted]. The measure of acidity in HVAC systems is stated in terms of a Total Acid Number or "TAN." TAN is typically reported as the number of milligrams of KOH (potassium hydroxide) that is required to neutralize one gram of an oil sample or "mg KOH/g." The HVAC systems at issue here utilize a form of polyolester oil commonly called "POE oil." [redacted]

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[15] In the ClimateMaster case, Emerson's designee admitted that dark color oil is common "if you had some wear going on in the compressor" and that while it could be related to some other kind of reaction, in Emerson's experience it is related "primarily to wear agents."

[16] Athough Carrier's designee said, "I think there was some confusion about whether or not the bearings Emerson uses were actually leaded or not, and I thought we found after the fact that they were not," Emerson's designee testified in the ClimateMaster case [redacted] Many documents in this case also confirm the presence of leaded bearings.

[redacted] According to Cartlidge and Schellhase (cited below), one ASHRAE Journal author has suggested that a TAN value of 1.5 mg KOH/g, after ASHRAE sealed tube aging for 14 days at 175°C, should be regarded as an alarm level for POE degradation. The post-reactivity level with Zerol Ice was over double that.

158. These TAN values are very high. NuCalgon, which markets and distributes Zerol Ice as "A/C Renew," has stated that "[f]or POE's, the generally accepted maximum is 0.16 mg, although some industry experts consider numbers as high as 0.21 mg marginally safe." (Kafura Ex. 67). Carrier claims that it does not have any internal criteria for TAN levels,[18] though Carrier's designee testified that one of Carrier's materials scientists believed that when TAN increases above .5 mg KOH/g, "then you need to look at the system to see, try and understand what's happening." Cartlidge and Schellhase conducted a study, sponsored by the Air-Conditioning and Refrigeration Technology Institute, concerning acceptable TAN levels for POE oil. Their report reflects that most industry participants believe TAN levels greater than 0.2 or 0.3 required action. Cartlidge & Schellhase, *Using Acid Number as a Leading Indicator of Refrigeration and Air Conditioning System Performance* (2003), https://www.osti.gov/servlets/purl/823889.

159. One document produced by Carrier indicates that a 6% concentration of Zerol Ice resulted in a TAN of 0.48, but in most systems in the field, Carrier's dosage of 4 ounces of Zerol Ice is well above a 6% concentration. Nevertheless, even the 0.48 TAN is very close to the 0.5%, which Carrier stated would require inquiry to "try and understand what's happening."

160. [redacted]

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[17] Emerson stated that the amount of oil in its 1.5 to 3 ton compressors in terms of ounces ranges from the "mid-twenties" to "low thirties." The dosage of Zerol Ice specified by Carrier to treat TXV failures is 4 ounces. Therefore, the Zerol Ice injection is around 12-18% of the oil charge.

[18] Carrier markets and distributes its own brand of acid test kits but these are manufactured by another company and Carrier claims it does not know what the kits measure or what level of acid will result in a "fail."

[redacted]

161. TAN is a measurement of the amount of acid present in an oil, not necessarily the strength of the acids that are present. Elevated TAN levels give an indication that the oil is potentially unstable. [redacted] Further, Carrier found significant increases in elastomer swell. All of these results demonstrate that the Zerol Ice has significant negative impacts.

162. Despite the fact that Carrier relied on Emerson to perform some of the critical testing of Zerol Ice, [redacted]

163. Moreover, [redacted] So, Emerson apparently never actually tested compressor performance with Zerol Ice in it.

164. These facts demonstrate that Zerol Ice does not render the Ryconox systems at issue in this lawsuit non-defective. Instead, while Zerol Ice may address the immediate symptoms of stuck TXVs due to Ryconox, it is harmful to systems, increases the acidity, and causes damage and premature wear.

165. Moreover, Zerol Ice is not always effective as a curative. One of Carrier's largest builder customers claimed only a [redacted] success rate with Zerol Ice. In

both Carrier's and Emerson's testing, sometimes the Zerol Ice would work initially but a high superheat condition would then return.

166. [redacted]

167. [redacted]

168. In sum, injecting Zerol Ice does not remove Ryconox nor does it render the Ryconox-containing systems non-defective. Instead, while it may prevent or alleviate the immediate symptoms of a stuck TXV, it causes further damage, presents new risks, and devalues the HVAC systems.

X. THE COST OF REMEDIATING ZEROL ICE CAN BE CALCULATED ON A CLASS-WIDE BASIS.

169. Because injecting Zerol Ice does not result in a defect-free system, Plaintiffs' counsel also asked me to opine as to the cost of remediating systems that have been injected with Zerol Ice.

170. As noted above, Zerol Ice mixes and travels with the oil in the system. So, removing Zerol Ice requires removing the oil from the system. Oil travels throughout the internal passages of the HVAC system along with the refrigerant,

however, the vast majority of oil resides in the compressor. As the compressor operates, it pumps oil from a sump in the bottom of the compressor, over the compressor parts (such as the scroll and bearings), and a small amount of that oil moves through the system with the refrigerant. Removing the oil, and the Zerol Ice with it, therefore requires removing the oil from the compressor and removing as much oil as possible from the rest of the system, and replacing it with clean oil.

171. As noted above, the compressors at issue in this case are hermetically sealed. Thus, there is no practical way to effectively remove all of the oil from the compressor in the field. Accordingly, replacing the oil would require replacing the compressor. To remove as much of the remaining Zerol Ice as possible from the rest of the system it is necessary to replace the filter-drier and TXV and recharge the unit with fresh refrigerant.

172. In terms of labor, this process is similar to the compressor change-out process described above in connection with the cost of removing Ryconox from a new unit but with the added extra steps of replacing the filter-drier and TXV. The replacement of the old refrigerant with new refrigerant does not add any labor cost. A compressor change out typically takes 4 hours. The additional time required to replace the filter-drier and TXV would add an hour of labor.

173. Using Carrier's nationwide average hourly reimbursement rate, as requested by Plaintiffs' counsel, I calculate the per unit labor cost to clean Zerol Ice out of a system to be [redacted].

174. The cost of the replacement compressors is set forth on Exhibit D. Again, the weighted average cost of a replacement compressor, for the systems at issue in this case, is $709.

175. I use a combined cost for the new TXV and filter-driers of $25, which is very conservative. This is the amount Carrier allowed for those components when they were replacing TXVs before the use of Zerol-Ice injections.

176. The approximate cost of fresh, R410A refrigerant is $6.00/pound. The rule of thumb is that 2-4 pounds of refrigerant are required for each ton of air conditioning capacity. Very conservatively, using 2 pounds of refrigerant per ton and a unit capacity of 1.5 tons (actual units in this class range from 1.5-5 tons) we calculate a refrigerant cost per unit of $18.

177. Therefore, I conclude that the total per unit average cost to perform this service would be $1,152 for each system in the class that has been injected with Zerol Ice.

178. Performing this process obviously would not reverse any premature wear, copper plating, or other harmful impacts that have already occurred since these systems have been running with Zerol Ice for months or years. So, this dollar amount is less than fully compensatory, even though it would provide at least partial relief to consumers whose systems have been injected with Zerol Ice.

Respectfully submitted,

Paul J. Sikorsky, P.E.

GEA Consulting

EXHIBIT A

Paul J. Sikorsky, P.E. - CV

Education

M.S. Michigan Technological University. Houghton, MI. 4 / 1978. Metallurgical Engineering

B.S. The University of Michigan. Ann Arbor, MI. 4 / 1977. Metallurgical Engineering

Experience

Consultant – Global Engineering Associates	12/2010 - Present
Staff Engineer. Chemistry and Materials Technology. Trane	11 / 2008 – 7 / 2010
Director. Strategic Supply Engineering. Trane	1 / 2005 – 11 / 2008
Project Manager. Engineering Technology. Trane	1 /2003 – 1/2005
Strategic Supply Engineer. Direct Material Sourcing. Trane	1 / 2001 – 1 / 2003
Sr. Principal Materials Engineer. Materials and Chemistry. Trane	10 / 1983 – 1 / 2001
Sr. Specification and Stds. Engineer. Engrg. G.O.. Caterpillar	1 /1981 – 10 / 1983
Research Engineer. Research Metallurgy. Caterpillar	8 / 1978 – 1 / 1981

Professional License

Registered Professional Metallurgical Engineer – Wisconsin	5 / 1988 - present

Certificate Number E-25599

Affiliations/Memberships

ASM International (formerly American Society for Metals) – Chair, Materials Property Database Committee; Member, Society Nominating Committee; Instructor, Metallurgy for non-metallurgists; Instructor, Steelmaking	1975 – present
American Foundrymen's Society	2005 – 2010
Engineers Without Borders	2008 – 2012
ASTM (formerly Association for Standards, Testing and Materials)- Chair, Committee, B.05.05 Copper Castings and Ingots for Re-Melting; Member, Committee B.05	1996 – 2003

Copper and Copper Alloys; Recipient, Distinguished Service Award, 2003; Recipient, Certificate of Appreciation, 1999

Heat Treating Society – Founding Member | 1994 – present

NSPE – National Society of Professional Engineers. Author, professional engineering exam for metallurgists | 1988 – 2001

Expertise

Failure analysis – determination of failure causes for components and for complex machinery including air conditioning compressors, chillers, unitary products, fans, air handlers, earthmoving equipment, diesel engines, transmissions, electric motors, rolling element and plain bearings

Material selection – selection of materials for engineered products to optimize reliability, manufacturability, cost and availability

Corrosion – evaluation of corrosive environments and selection of materials to survive exposure to those environments

Heat treatment – development of heat treatment processes for ferrous and non-ferrous metals to improve material strength, toughness, wear resistance and corrosion resistance

Brazing – selection of brazing filler metals and processing to join a wide variety of metals used in HVAC equipment. Provided brazing training to manufacturing facilities in the US, Asia and Europe

Bearing metallurgy – selection and processing of specialized materials used in rolling element and plain bearings. Development of tribological tests for bearing materials

Sheet metal forming – selection of materials for sheet metal forming applications including deep drawing, bending and stretching. Application of circle-grid analysis to facilitate application of appropriate materials

Supplier selection and development – evaluation, selection and development of suppliers for raw materials as well as cast, forged, machined, formed, heat treated and coated components used in engineered products

Fatigue – complex analysis of engineered structures and components with the goal of selecting materials and processing to maximize fatigue resistance

EXHIBIT B

Sikorsky Testimony

I, Paul J. Sikorsky, P.E., provided expert testimony in the following cases within the past four years:

1. *Kostur v. Goodman Glob., Inc.*, No. 2:14-cv-01147-NS (E.D. Pa.) (deposed on December 10, 2014, in New York, NY);

2. *McVicar v. Goodman Glob., Inc.*, No. 13-1223-DOC (C.D. Cal.) (deposed on April 23, 2015, in New York, NY);

3. *PB Prop. Mgmt. Inc. v. Goodman Mfg. Co., L.P.*, No. 3:12-cv-1366-HES (M.D. Fla.) (deposed on April 23, 2015, in New York, NY);

4. *Gustafson v. Goodman Mfg. Co. LP*, No. 3:13-cv-08274-PCT-JAT (D. Ariz.) (deposed on October 20, 2015, in Chicago, IL);

5. *Harris v. Nortek Glob. HVAC LLC*, 1:14-cv-21884-JAL (S.D. Fla.) (deposed on November 10, 2015, in Chicago, IL); and

6. *Calallen Indep. Sch. Dist. v. Teal Constr.*, No. 2014 DCV-6027-B (117th Judicial Dist. Ct., Nueces Cnty., Tex.) (deposed on December 7, 2016, in Corpus Christi, TX).

EXHIBIT C

Appendix of Materials

- Amended Class Action Complaint and accompanying exhibit, *Oddo v. Arcoaire Air Conditioning & Heating*, No. 8:15-cv-01985 (C.D. Cal. Mar. 7, 2016).
- Deposition transcript and accompanying exhibits of Carrier's Fed. R. Civ. P. 30(b)(6) designee, Christopher Kafura, taken by plaintiffs on January 26, 2018, in *Oddo v. Arcoaire Air Conditioning & Heating*, No. 8:15-cv-01985 (C.D. Cal.).
- Deposition transcript and accompanying exhibits of Emerson Climate Technologies's Fed. R. Civ. P. 30(b)(6) designee, Kenneth J. Monnier, taken by plaintiffs on December 14, 2017, in *Oddo v. Arcoaire Air Conditioning & Heating*, No. 8:15-cv-01985 (C.D. Cal.).
- Deposition transcript and accompanying exhibits of Emerson Climate Technologies's Fed. R. Civ. P. 30(b)(6) designee, Kenneth J.Monnier, taken by defendant on December 15, 2017, in *Oddo v. Arcoaire Air Conditioning & Heating*, No. 8:15-cv-01985 (C.D. Cal.).
- Deposition transcript and accompanying exhibits of Emerson Climate Technologies's Fed. R. Civ. P. 30(b)(6) designee, Kenneth J. Monnier, taken on April 26, 2017, by plaintiffs in *Emmert v. Climatemaster, Inc.*, No. 5:15-cv-00458 (W.D. Okla.).
- Inspection data from taken by defendant at its inspection of plaintiffs' HVAC Systems entitled "INSPECTION STATISTICS" in *Oddo v. Arcoaire Air Conditioning & Heating*, No. 8:15-cv-01985 (C.D. Cal.).
- Discovery materials produced by Carrier, including the following documents beginning with Bates number CARRIER_:

0000141	0001175	0002675	0005280	0005482
0000181	0001539	0002685	0005281	0005485
0000385	0001565	0002702	0005312	0005532
0000757	0001567	0002708	0005321	0005557
0000761	0002278	0002812	0005417	0005671
0000807	0002292	0003112	0005444	0005696
0000823	0002662	0005276	0005462	0005799

0005894	0010290	0014224	0016168	0022847
0005896	0010292	0014227	0016183	0023057
0005898	0010573	0014230	0016283	0023073
0005932	0010956	0014233	0016305	0023493
0005940	0010997	0014236	0016677	0023541
0005956	0011273	0014239	0016714	0023773
0005975	0011276	0014242	0017198	0024258
0005979	0011305	0014254	0017199	0024266
0006156	0011318	0014308	0017882	0024284
0006157	0011328	0014325	0018009	0025006
0006158	0011341	0014338	0018010	0025665
0006191	0011358	0014434	0018326	0026095
0006224	0011367	0014458	0019912	0028022
0006231	0011369	0014460	0019913	0028046
0006252	0011425	0014610	0020662	0028102
0006399	0011447	0014919	0020665	0028224
0006410	0012823	0014920	0020740	0029018
0006584	0013734	0014928	0020827	0029344
0006586	0013820	0015085	0020874	0029444
0006708	0014198	0015086	0020876	0029449
0006823	0014200	0015132	0020877	0030815
0008549	0014203	0015133	0020931	0030890
0008551	0014206	0015207	0020950	0031343
0008552	0014209	0015689	0020969	0031351
0008646	0014212	0016050	0022032	0031528
0008786	0014215	0016051	0022766	0032597
0008787	0014218	0016064	0022768	0032887
0008789	0014221	0016066	0022784	0033003

0033062	0034272	0037948	0042747	0046807
0033070	0034274	0038263	0043188	0058228
0033085	0034359	0038276	0043190	0058348
0033092	0034385	0038559	0043206	
0033124	0034391	0039263	0043243	
0033188	0034424	0041357	0043278	
0034269	0034573	0042349	0043279	
0034270	0037933	0042440	0043390	
0034271	0037945	0042666	0043885	

- Discovery materials produced by nonparty Emerson Climate Technologies, including the following documents beginning with Bates number EMERSON:

000088	002692	006620	011565	013376
000216	003158	007374	011727	013480
000235	003202	008279	011728	013482
000274	003223	008882	011793	013486
000278	003319	009265	011795	013575
000310	003677	009369	011796	013749
000315	004761	009649	011797	013957
000543	004868	009877	011802	013958
000881	005072	009880	011909	014036
000995	005269	009934	011910	014531
001078	005414	009936	012023	014666
001177	006608	010860	012125	014795
001188	006610	010988	012645	014857
001383	006612	011535	012664	014983
002397	006614	011536	012691	015110
002442	006616	011562	012883	015186
002618	006618	011564	013320	015984

015987	018514	018926	019019	019043
018460	018745	018955	019020	019044
018465	018789	018982	019021	
018466	018830	019010	019024	
018487	018859	019013	019041	
018505	018896	019018	019042	

- Discovery materials produced by nonparty Shrieve Chemical Products, including documents beginning with Bates number SCP:

000301

000310

- Discovery materials produced by plaintiffs, including:

GALLAGHER0000203

GALLAGHER0000204

GALLAGHER0000205

ODDO00000086

- Publicly available documents, including:

Warranty Week, *Appliance & HVAC Warranty Report* (May 19, 2016), www.warrantyweek.com/archive/ww20160519.html;

Pricing information for Zerol Ice on www.supplyhouse.com; www.controlscentral.com; www.bakerdist.com;

Compressor pricing websites included on Exhibit D; and

Cartlidge & Schellhase, *Using Acid Number as a Leading Indicator of Refrigeration and Air Conditioning System Performance* (2003), https://www.osti.gov/servlets/purl/823889

EXHIBIT D

Compressor Price Chart

CompressorMfgModel	Number of compressors	Pricing	Average Price
ZP24K5E-PFV-130	180,816	$639.99 (North America HVAC); $579.25(Saez Distributors), $659.99 (The AC Outlet)	$626.30
ZP20KAE-PFV-130	134,979	$619.99 (North America HVAC); $649.99 (AC Parts Distributors);	$634.99
ZP36K5E-PFV-130	68,086	$739.99 (North America HVAC), $749.92 (AC Parts Distributors)	$744.96
ZP29K5E-PFV-130	64,158	$679.99 (North America HVAC); $699.92 (AC Parts Distributor)	$690.00
ZP20K5E-PFV-130	60,698	$649.92 (AC Parts Distributors); $695.41 (Replacement HVAC)	$672.50
ZP16KAE-PFV-130	58,214	$649.92 (AC Parts Distributors)	$649.92
ZP21K5E-PFV-130	48,707	$654.25 (original price on Freeman Liquidators); $649.92 (AC Parts Distributors)	$652.09

ZP38K5E-PFV-130	46,047	$739.99 (North America HVAC); $749.92 (AC Parts Distributor)	$744.96
ZP16K5E-PFV-130	45,947	$649.92 (AC Parts Distributors); $748.91 (Replacement HVAC)	$699.42
ZP21K5E-PFV-13R	43,726	$649.92 (AC Parts Distributors)	$649.92
ZP28K5E-PFV-130	36,422	$699.92 (AC Parts Distributors); $802.41 (Replacement HVAC)	$751.17
ZP34K5E-PFV-130	32,475	$669.99 (North America HVAC); $749.92 (AC Parts Distributor)	$709.96
ZP44K5E-PFV-130	30,003	$819.99 (North America HVAC); $749.92 (AC Parts Distributor)	$784.96
ZP31K5E-PFV-130	29,659	$748.91 (Replacement HVAC); $679.99 (North America HVAC); $699.92 (AC Parts Distributors)	$709.61
ZPS31K5E-PFV-130	27,774	$849.92 (AC Parts Distributors)	$849.92
ZP31K5E-PFV-13R	24,848	$699.92 (AC Parts Distributors)	$699.92

ZPS40K5E-PFV-130	24,035	$899.92 (AC Parts Distributors)	$899.92
ZP28K5E-PFV-13R	21,502	$699.92 (AC Parts Distributors)	$699.92
ZP16K5E-PFV-13R	21,389	$649.92 (AC Parts Distributors)	$649.92
ZP42K5E-PFV-130	20,357	$819.99 (North America HVAC); $749.92 (AC Parts Distributors); $855.91 (Replacement HVAC)	$808.61
ZP25K5E-PFV-13R	20,351	$649.92 (AC Parts Distributors)	$649.92
ZP38K5E-PFV-13R	15,785	$749.92 (AC Parts Distributors); $739.99 (North American HVAC)	$744.96
ZP42K5E-PFV-13R	14,334	$819.99 (North America HVAC); $749.92 (AC Parts Distributors)	$784.96
ZP51K5E-PFV-130	13,889	$1,069.91 (Replacement HVAC); $849.92 (AC Parts Distributors)	$959.92
ZPS49K5E-PFV-130	13,319	$1049.92 (AC Parts Distributors)	$1,049.92

ZP51K5E-TF5-130	13,237	$949.92 (AC Parts Distributors)	$949.92
ZPS21K5E-PFV-130	11,664	$686.10 (Comfort Gurus)	$686.10
ZP54K5E-PFV-13R	11,495	$899.92 (AC Parts Distributor)	$899.92
ZP25K5E-PFV-130	11,194	$747.34 (Sears Parts Direct); $649.92 (AC Parts Distributors); $639.99 (North America HVAC)	$679.08
ZP51K5E-PFV-13R	8,596	$849.92 (AC Parts Distributors)	$849.92
ZP51K5E-TFD-130	4,243	$1016.41 (Replacement HVAC); $949.92 (AC Parts Distributors)	$982.92
ZP54K5E-TF5-130	3,550	$999.92 (AC Parts Distributors); $1016.41 (Replacement HVAC)	$1,008.17
ZP39K5E-PFV-130	3,328	$855.91 (Replacement HVAC); $749.92 (AC Parts Distributors); $739.99 (North America HVAC)	$781.94
ZP39K5E-TF5-130	3,154	$849.92 (AC Parts Distributor); $909.41 (Replacement HVAC)	$879.67

ZP42K5E-TF5-130	3,121	$849.92 (AC Parts Distributor); $909.41 (Replacement HVAC)	$879.67
ZP31K5E-TF5-130	3,065	$855.91 (Replacement HVAC); $799.92 (AC Parts Distributors)	$827.92
ZP54K5E-PFV-130	2,912	$962.91 (Replacement HVAC); $899.92 (AC Parts Distributors)	$931.42
ZP29K5E-TF5-130	2,263	$855.91 (Replacement HVAC); $799.92 (AC Parts Distributors)	$827.92
ZPS49K4E-PFV-130	2,008	$1123.41 (Replacement HVAC); $1049.92 (AC Parts Distributors)	$1,086.67
ZPS30K5E-PFV-130	1,836	$849.92 (AC Parts Distributors)	$849.92
ZP29K5E-PFV-13R	1,498	$699.92 (AC Parts Distributors)	$699.92
ZP54K5E-TFD-130	1,468	$999.92 (AC Parts Distributors); $962.91 (Replacement HVAC)	$981.42
ZP31K5E-TFD-130	1,242	$799.92 (AC Parts Distributors); $855.91 (Replacement HVAC)	$827.92

ZP36K5E-TF5-130	1,230	$855.91 (Replacement HVAC); $799.92 (AC Parts Distributors)	$827.92
ZP42K5E-TFD-130	1,226	$909.41 (Replacement HVAC); $849.92 (AC Parts Distributors)	$879.67
ZP24K5E-TF5-130	1,052	$802.41 (Replacement HVAC); $749.92 (AC Parts Distributors)	$776.17
ZP49K5E-PFV-130	984	*For compressor models with less than 1000 units, we use the weighted average price of all compressors.	$709.40
ZP29K5E-TFD-130	932		$709.40
ZP39K5E-TFD-130	867		$709.40
ZPS20K5E-PFV-130	804		$709.40
ZPS35K5E-PFV-130	794		$709.40
ZPS26K5E-PFV-130	752		$709.40

ZP20K5E-PFV-13R	720		$709.40
P739002-2010-10	686		$709.40
ZP20K5EPFJ130	663		$709.40
ZP36K5E-TFD-130	545		$709.40
ZP67KCETFD13A	500		$709.40
ZP38K5E-TF5-130	464		$709.40
ZP28K5E-TF5-130	392		$709.40
ZP24K5EPFJ130	373		$709.40
ZP61KCETFD130	253		$709.40

ZP25K5ETF5130	235		$709.40
P739001-2010-10	194		$709.40
ZP51K5E-TFE-130	185		$709.40
ZP38K5ETFD130	116		$709.40
P739005-2010-10	91		$709.40
ZP36K5EPFJ130	91		$709.40
ZP31K5EPFJ130	79		$709.40
ZPS49K5E-TF5-130	59		$709.40
ZP39K5E-TFE-130	52		$709.40

ZP25K5EPFJ130	30		$709.40
ZPS49K5E-TFD-130	27		$709.40
ZPS30K5E-TF5-130	21		$709.40
ZP29K5E-TFE-130	20		$709.40
ZPS26K5E-TF5-130	17		$709.40
ZPS40K5E-TF5-130	15		$709.40
ZPS35K5E-TF5-130	12		$709.40
ZPS40K5E-TFD-130	8		$709.40
ZPS30K4EPFV130	5		$709.40

ZPS30K5E-TFD-130	5		$709.40
P739000-2010-10	3		$709.40
ZPS20K4EPFV130	2		$709.40
ZPS51K4EPFV130	2		$709.40
ZP42K6E-PFV-130	1		$709.40

EXHIBIT E

Split System Schematic